الإسم : محمد أحمد عبداللطيف نمير

السكشن : 3

Sheet 1 (a)

1. Discuss the main types of renewable energy sources.

اكتب أي هري في الطاقة المتجدده اللي فاكره من التحويل

---

2. What factors must be taken into account while calculating the resistance of overhead line conductors? How are these factors accounted for?

$$R = \frac{\rho L}{A} \quad 1 - Temprature\ 2 - Length\ 3 - Corss\ section\ Area$$

It must be that the T.L has small resistance so as to have small voltage drop

---

3. Discuss the main precautions and regulations which electrical workers must follow to avoid any damage to the equipment and workers.

1- **Avoid getting wet or water near electricity**
2- **Use the proper insulated tools**
3- **Avoid touching the wires directly**
4- **Know the code of your country while dealing with higher voltages**
5- **Chech the earthing of the system**

---

4. A single-phase two-wire transmission line, 15 km long, is made up of round conductors, each 0.8 cm in diameter, separated from each other by 40 cm. Calculate the total inductance of the line.

$$r = 0.4 * 10^{-2} \ ; \quad D = 40 * 10^{-2}$$

$$L\ (per\ meter) = 2*10^{-7}\ln\left(\frac{D}{r'}\right) = 2*10^{-7}\ln\left(\frac{40*10^{-2}}{0.7788*\ 0.4*10^{-2}}\right) = \mathbf{9.71\cdot 10^{-7}}\ \frac{H}{m}$$

$$L_{total} = 2*15*1000*9.71*10^{-7} = 0.029\,H$$

---

5. Find the inductance per unit length of the single-phase shown in Figure 1. Conductors a, b, and c are of 0.2 cm radius, and conductors d and e are of 0.4 cm radius.

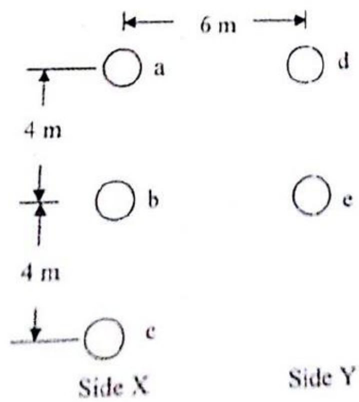


Figure 1

$$r_a = r_b = r_c = 0.2*10^{-2}\,m\ \ ; r_d = r_e = 0.4*10^{-2}\,m$$

$$D_m = \sqrt[6]{D_{ad}\,D_{ae}\,D_{bd}\,D_{be}D_{cd}D_{ce}} = \sqrt[6]{6*7.2*7.2*6*10*7.2} = 7.157$$

$$D_{SX} = \sqrt[9]{D_{aa}D_{ab}D_{ac}D_{ba}D_{bb}D_{bc}D_{ca}D_{cb}D_{cc}}$$
$$= \sqrt[9]{0.7788*0.2*10^{-2}*4*8*4*0.7788*0.2*10^{-2}*4*8*4*0.7788*0.2*10^{-2}}$$
$$= 0.341$$

$$D_{SY} = \sqrt[4]{D_{de}D_{dd}D_{ed}D_{ee}} = \sqrt[4]{4*0.7788*0.4*10^{-2}*4*0.7788*0.4*10^{-2}} = 0.112$$

$$L_X = 2*10^{-7}\ln\left(\frac{D_m}{DSx}\right) = 2*10^{-7}\ln\left(\frac{7.157}{0.341}\right) = \mathbf{6.088\cdot 10^{-7}}\ H/m$$

$$L_Y = 2*10^{-7}\ln\left(\frac{D_m}{DSy}\right) = 2*10^{-7}\ln\left(\frac{7.157}{0.112}\right) = \mathbf{8.315\cdot 10^{-7}}\ H/m$$

$$L_T = L_X + L_Y = 14.4*10^{-7}\ H/m$$

6. **Three-phase, 50 Hz, transmission line is arranged with 1.5 meter between any two conductors and each conductor diameter of 1.5 cm. Calculate the inductance per phase and corresponding value of the reactance. Assume the line to completely transpose.**

Assume the line to be completely transpose means it has the same inductance all along the T.L

$$D = 1.5\,m \quad ; r = 0.75 * 10^{-2} ;$$

$$L_a = L_b = L_c = 2 * 10^{-7}\, ln\left(\frac{D}{r'}\right) = 2 * 10^{-7} \ln\left(\frac{1.5}{0.7788 * 0.75 * 10^{-2}}\right) = \mathbf{1.11 \cdot 10^{-6}}\ \frac{H}{m}$$

$$X_a = X_b = X_c = 2\pi f\, L = 2\pi * 50 * 1.11 * 10^{-6} = 0.0003487167845\ \Omega/m$$

---

7. **Calculate the inductance and reactance of each phase of a three-phase 50Hz overhead high tension line (HTL) which has conductors of 1.5cm diameter. The distance between the three-phases are (i) 5cm between A and B, (ii) 4m between B and C and (iii) 3m between C and A. Assume that the phase conductors are transposed regularly.**

$$3-\phi \quad ; f = 50\,Hz \ ; r = 0.75 * 10^{-2} \ ; D_{AB} = 5 \,; D_{BC} = 4 \,; D_{CA} = 3$$

$$D_M = \sqrt[3]{5 * 4 * 3} = 3.915\,m$$

$$L(per\ phase\,) = 2 * 10^{-7} \ln\left(\frac{D_m}{r'}\right) = 2 * 10^{-7} \ln\left(\frac{3.915}{0.7788 * 0.75 * 10^{-2}}\right)$$

$$= 1.302 * 10^{-6} H/m$$

$$X\ (per\ phase\,) = 2\pi * 50 * 1.302 * 10^{-6} = 40.9 * 10^{-5}\ \Omega/m$$

---

8. **Three-phase double-circuit line is composed of 0.023 ft diameter. The line is arranged as shown in Figure 2, and is completely transposed. Find the 50 Hz inductive reactance per phase per mile.**

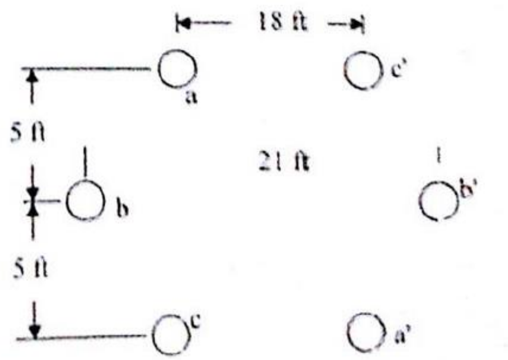


Figure 2

$$r = 0.0115\,ft$$

$$D_M = \sqrt[3]{D_{AB}D_{BC}D_{CA}}$$
$$D_{AB} = \sqrt[4]{5.2 * 20.13 * 20.13 * 5.2} = 10.23$$

$$D_{BC} = \sqrt[4]{5.2 * 20.13 * 20.13 * 5.2} = 10.23$$
$$D_{CA} = \sqrt[4]{10 * 18 * 18 * 10} = 13.42$$

$$\therefore D_M = \sqrt[3]{10.23 * 10.23 * 13.42} = 11.198\,ft$$

$$D_{SA} = \sqrt[4]{0.7788 * 0.0115 * 0.7788 * 0.0115 * 20.6 * 20.6} = 0.43$$

$$D_{SB} = \sqrt[4]{0.7788 * 0.0115 * 0.7788 * 0.0115 * 21 * 21} = 0.43$$
$$D_{SC} = \sqrt[4]{0.7788 * 0.0115 * 0.7788 * 0.0115 * 20.6 * 20.6} = 0.43$$
$$\therefore D_S = 0.43$$
$$L = 2 * 10^{-7} \ln\left(\frac{11.198}{0.43}\right) = 6.519 * 10^{-7}\,H/m$$

$$X = 2 * \pi * 50 * 6.519 * 10^{-7} = 0.0002048\,\Omega/m$$

1. What are the difference between geometric mean distance and mutual geometric mean distance?

Dm : the mean geometric distance between different conductors

Ds : the mean geometric distance between the composed wires of the same conductor

2. A 20 km single phase line has two parallel conductors separated by 1.5 meters. The diameter of each conductor is 0.823 cm. If the conductor has a resistance of 0.311 ohm/m, find the loop impedance of this line at 50 Hz.

$$D = 1.5\, m\, ; r = 0.4115 * 10^{-2}\, ; R = 0.311\Omega/cond/m$$

$$L = 2 * 10^{-7} \ln\left(\frac{1.5}{0.7788 * 0.4115}\right) = 3.08 * 10^{-7}$$

$$X_L = 2 * \pi * 50 * 3.08 * 10^{-7} = 9.67 * 10^{-5}\ \Omega/cond/m$$

$$Z = R + jX_L = 2 * 20 * 1000 * 0.311 + j\ (2 * 20 * 1000 * 9.67 * 10^{-5})$$
$$= 12440 + j\ 3.868\ \Omega$$

3. Find the loop inductance per km of a single phase overhead transmission line when conductors have relative permeability of (i) 1 (ii) 100. Each conductor has a diameter of 1 cm and they are spaced 5 m apart.

$$r = 0.5 * 10^{-2}\ m; D = 5\, m$$

$$L = \frac{\mu}{2\pi} \ln\left(\frac{D}{r'}\right)$$

$$i)\ \ L = \frac{\mu_0}{2\pi} \ln\left(\frac{5}{0.7788 * 0.5 * 10^{-2}}\right) = 1.43 * 10^{-6}\ H/m$$

$$ii)\ L = \frac{100 * \mu_0}{2\pi} \ln\left(\frac{5}{0.7788 * 0.5 * 10^{-2}}\right) = 0.0001\ H/m$$

With higher relative permeability the inductance is increased

---

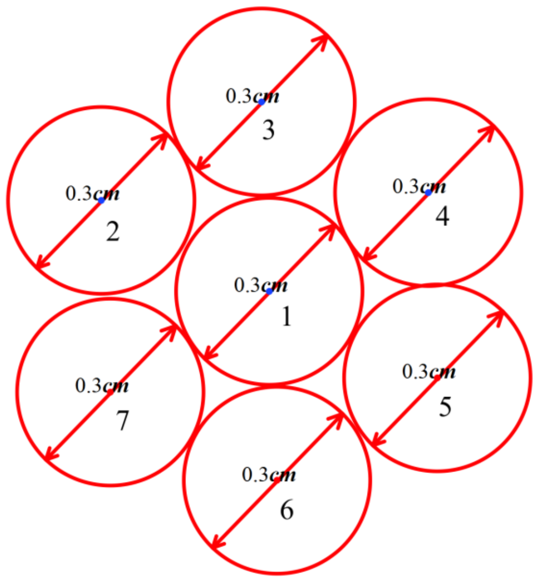
4. One circuit of a single-phase transmission line is composed of three solid O.25 cm-radius wires and the horizontal distance between any two adjacent wires is 6 cm. The return circuit is composed of two O.5 cm-radius wires and the horizontal distance between the two wires is 8 cm. Assume all wires are at the same horizontal line with 10 cm between the two groups. Find the inductance due to the current in each side of the line and the inductance of the complete line in henrys per meter.

$$r = 0.25 * 10^{-2}\ m\, ; D = 6 * 10^{-2} m\, ; \rightarrow go$$
$$r = 0.5 * 10^{-2} m\, ; D = 8 * 10^{-7}\ m \rightarrow return$$

هترسمهم مجموعتين و تحلها زي رقم 5 الشييت اللي فات

5. The distance between conductors or a single-phase line is 100 cm. Each of its conductors is composed of six strands symmetrically placed around one center strand so that there are seven equal strands. The diameter of each strand is 0.3 cm. Find the geometric mean distance and the inductance of the line.

$$D = 1\,m\,; r = 0.015$$



المفروض نجيب Ds بين النقط دي بس العمر مش بعزقه

Sheet (2)

1- A single phase 30 Km long transmission line consists of two parallel long straight conductors each 5 mm in diameter and the spacing between conductors is 1.5 m. If the line voltage is 50-Kv, 50-Hz determine the charging current of the open circuited line.

$$r = 2.5 * 10^{-3}\ m\ \ ; 2\ conductor\,; s = 30 *\ 10^{3} m\,; D = 1.5\,; V_L = 50 * 10^{3} V$$

$$C = \frac{2\pi\epsilon_0}{\ln\left(\frac{1.5}{2.5 * 10^{-3}}\right)} = 8.6926 * 10^{-12} \quad F/m$$

$$I_{ch} = 2\pi f C \frac{V_L}{\sqrt{3}} = 2\pi * 50 * 8.6926 * 10^{-12} * 2 * 30 * 10^{3} * \frac{50000}{\sqrt{3}} = 4.73\ A$$

2- Calculate the charging current per phase for a 3-phase, 50-Hz, 66-Kv overhead line conductors for the arrangment shown in Figure 1. The conductor diameter is 1.25 cm and the line length is 100 Km. Assume complete transposition of the line.

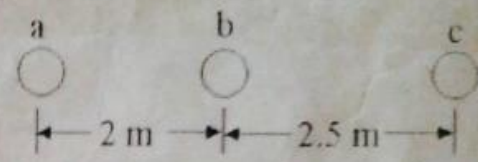


Figure 1

$$r = \frac{1.25}{2} * 10^{-2}\ m\ \ ; Length = 100 * 10^{3} m$$

$$D_m = \sqrt[3]{2 * 2.5 * 4.5} = 2.8231\ m$$

$$\therefore C = \frac{2\pi\epsilon_0}{\ln\left(\dfrac{2.8231}{\frac{1.25}{2} * 10^{-2}}\right)} = 9.0964 * 10^{-12}\ \ F/m$$

$$I_{ch} = 2 * \pi * 50 * 9.0964 * 10^{-12} * 100 * 10^{3} * 66 * \frac{10^{3}}{\sqrt{3}} = 10.8894\ A$$

3- Figure 2 shows the spacings of a double circuit 3-phase overhead line. Find the formula for calculating capacitance per phase per Km in terms of spacing D and radius r

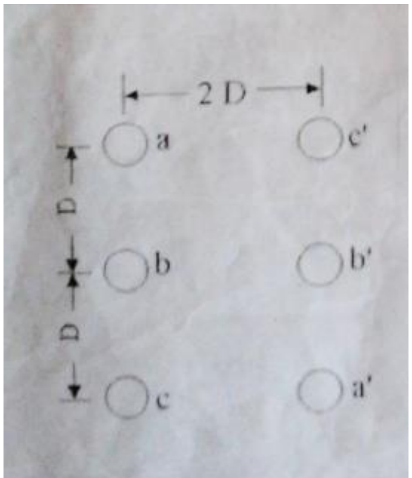


Figure 2

$$C = \frac{2\pi\epsilon_0}{\ln\left(\frac{D_m}{D_S}\right)}$$

$$D_m = \sqrt{D_{AB} D_{BC} D_{CA}}$$

$$D_{AB} = \sqrt[4]{D * \sqrt{5}D * \sqrt{5}\ D * D} = 1.5\ D$$

$$D_{BC} = \sqrt[4]{D * \sqrt{5}D * \sqrt{5}D * D} = 1.5\ D$$

$$D_{CA} = \sqrt[4]{2D * 2D * 2D * 2D} = 2D$$

$$D_m = 1.65\ D$$

ونفس الحوار ونجيب ال D_S

4- The six conductors of a double circuit transmission line are arranged as shown in figure 3. The diameter of each conductor is 2.5 cm. Find the capacitive reactance to neutral and the charging current per Km per phase at 132-Kv and 50-Hz, assuming that the line is regularly transposed.

مفيش جديد نفس القوانين ونفس التعويض

Sheet (3)

Q١: Write brief comments about the following expressions:

١. Skin Effect
٢. Voltage regulation
٣. Transposition of conductors

Skin Effect :

In **DC :** the current is uniformly distributed over the cross section of the conductor

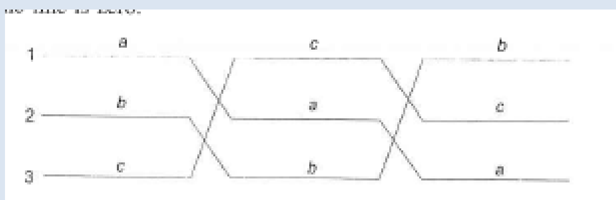
But in **AC :** the current is not uniformly distributed over the cross section of the conductor and this increases with higher frequencies so $R_{AC} > R_{DC} \Rightarrow \quad R_{AC} = 1.15\ R_{DC}$

Voltage Regulation :

The ration between the no load voltage and the full load voltage and the full load voltage $\frac{V_{n.l} - V_{f.l}}{V_{f.l}}$

Transposition

It's a technique performed to the case of unequally spaced phases to have a nearly the same inductance per phase that by changing the position of the phase as shown in the fig.



Q٢: A three phase, ٦٠ Hz overhead short transmission line has a line to line voltage of ٢٣ KV at the receiving end. The total line impedance of ٢,٤٨+j٦,٥٧ ohm per phase. The connected load is rated ٩ MW with a receiving end lagging power factor of ٠,٨٥.

١. Calculate the line to neutral voltage at the sending end and power factor
٢. Calculate line efficiency and voltage regulation
٣. Find the ABCD constants of the line
٤. Draw the phasor diagram

① (3-Φ), 60 Hz, o.H.TL

$V_r(L-L) = 23KV \quad Z/ph = 2.48 + J6.57\ \Omega$

$P_r = 9\,MW \quad Pf_r = 0.85$ Lag

Calculate: $V_s(L-G)$, Pf_s

η line, V_{reg} (line)

A, B, C, D

Draw phasor digrame

① $V_r = 23K \div \sqrt{3} = 13.279\ K$

$V_s = V_r + I_r Z$

$P_r\,ph = \frac{9 * 10^6}{3} = 3MW$

$Pf_r = 0.85$ Lag

$I_r = \frac{P_r ph}{V_r ph \cdot Pf_r} \angle -\cos^{-1} Pf_r = 265.78 \angle -31.78\ A$

$V_s = 13.279K + 265.78 \angle -31.78 * (2.48 + J6.57)$

$14802.7 \angle 4.406\ V$

$\rightarrow Pf_s = \cos(4.4 + 31.8)$

$= 0.81$ Lag

② $\eta = \frac{P_{r\phi}}{P_{s\phi}} * 100$

$P_s = |V||I_s|\ Pf_s$

$\therefore \eta = \frac{3 * 10^6}{14.8K * 265.8 * 0.81} * 100 = 94.149\ \%$

$V_{reg} = \frac{V_{NL} - V_{FL}}{V_{FL}} = \frac{14.8 * 10^3 - 13.27 * 10^3}{13.27 * 10^3} * 100$

$= 11.3\ \%$

ع الملحة تلاد comment لتاع الفاعل ياعنا على الكرت م

- بالنسبة للكفاءة فهي جيدة ∴ تأثير المقاومة صغير
- بالنسبة للـ Vreg فهو مرتفع جداً وذلك لأن تأثير (L) مرتفع

③ For short T.L

$A = D = 1$

$C = 0$

$B = Z = 7.022 \angle 69.3$

④ نراعي واحنا بنرسم الـ phasor القيم والأرقام
يعني مش هرسم بـ scale أوي بس أراعي النسبة بين الأطوال
ع المسألة دي مثلاً عندي $V_S = 14{,}...$ والـ $V_r = 13{,}...$ يعني قريبين من بعض

Q٣: A ٢٢٠ KV, three phase transmission line is ٤٠ km long. The resistance per phase is ٠.١٥ ohm per km and the inductance per phase is ١.٣٣ mH per km. The shunt capacitance is negligible. Use the short line model to find the voltage and power at the sending end and the voltage regulation and efficiency when the line is supplying a three phase load of ٣٨٠ MVA at ٠.٨ power factor lagging at the ٢٢٠ KV.

② $3-\phi$, $l = 40\,km$, $R/ph/km = 0.15\,\Omega$

$L/ph/km = 1.33\,mH$

Calculate: V_s, P_s, V_{reg}, η (if)

$3-\phi$ Load $\rightarrow$ S 380 MVA

$pf = .8$ Lag

$V_r = 220\,KV$

$Z = 0.15 * 40 + J\,10\pi * 40 * 1.33 * 10^{-3}$

$= (6 + J16.7)$

$V_s = V_r + I_s Z$

$V_{r\phi} = \frac{V_{rL}}{\sqrt{3}} = \frac{220K}{\sqrt{3}} = 127\,K$

$I_r = \frac{S_\phi}{V_{r\phi}} \angle -\cos^{-1} pf$

$\therefore I_r = 997.3 \angle -36.86$

$V_s = 127K + (997.3 \angle -36.86 * 6 + J16.7)$

$= 142.1 \angle 3.94\ KV$

$V_{s(L)} = V * \sqrt{3}$ #

$P_s = 3|V_{s\phi}|\,|I_s|\,pf_s$

$pf_s = \cos(\hat{V}_{s\phi} - \hat{I}_s)$

$= \cos(3.94 + 36.87) = 0.76$ Lag

$\therefore P_s = 321.5\ MW$ #

$$\eta = \frac{P_{r\phi}}{P_{s\phi}} = \frac{P_{r\,3\phi}}{P_{s\,3\phi}} * 100$$

$$= \frac{S_{r\,3\phi} * Pf_r}{321.5 * 10^6} * 100 = 94.56\ \%$$ #

$$V_{reg} = \frac{V_{NL} - V_{FL}}{V_{FL}}$$

$$= \frac{V_{s\phi} - V_{r\phi}}{V_{r\phi}} * 100 = 11.78\ \%$$

Sheet (4)

1- The per-phase parameters for a 60-Hz, 100-Km long transmission line are R=2.07 ohm, L=310.8 mH, and C=1.4774 μF. The line supplies a 100-Mw, star connected load at 215-Kv (line to line) and 0.9 power factor lagging. Determine the ABCD constants and then calculate the sending end voltage, using the nominal-π circuit representation.

1) 3-ϕ , 60 HZ , 100 km

$R = 2.07\,\Omega$ $L = 310.8\,mH$ $C = 1.4774\,\mu f$

Load : 100 MW

215 KV

PF = .9 Lag

→ Requarde : ① A, B, C, D

② Vs

π connection

SoL

$Z_{TL} = R + jX_L = 117.17 \angle 88.99^\circ\ \Omega$

$y = 2\pi f C \angle 90 = 0.559 * 10^{-3} \angle 90$

$A = D = 1 + \frac{Zy}{2} = 0.9674 \angle 0.034$

$B = Z = 117.17 \angle 88.99$

$C = y\left(1 + \frac{Zy}{4}\right) = 5.49 * 10^{-4} \angle 90$

$V_S = AV_r + BI_r$

$V_r = \frac{215}{\sqrt{3}} * 10^3\ V$

$i_r = \frac{\frac{100}{3} * 10^6}{\frac{215}{\sqrt{3}} * 10^3 * .9} \angle -\cos^{-1} pf = 298.37 \angle -25.96\ A$

$\therefore V_{S\phi} = 139.42 \angle 12.96\ KV$

$V_{SL} = 241.5\ KV$

2- A 3-phase, 50-Hz overhead transmission line 100 Km long has the following constants:

Resistance/Km/phase = 0.1 ohm, inductive reactance/Km/phase = 0.2 ohm,

Capacitive susceptance/Km/phase = 0.04×10^{-4} mho.

Determine: (i) the sending end current. (ii) sending end voltage.

(iii) transmission efficiency when supplying a balanced load of 10000 Kw at 66-Kv, 0.8 power factor lagging. use nominal-T method.

2) $3-\phi$, $F = 50$ HZ, 100 km

$R/km/ph = 0.1\ \Omega$ $XL/km/ph = 0.2\ \Omega$

$y/km/ph = 0.04 * 10^{-4}$ ℧

Load 10^4 KW

66 KV

.8 Lag

Req → ① I_S ② V_S ③ η

T connection

$R_T = .1 * 100 =$

$XL_T = .2 * 100 =$

$y_T = .04 * 10^{-4} * 100 = 4*10^{-4} \angle 90$

$Z_T = R + JXL = 10 + J20$

$A = D = 1 + \frac{Zy}{2} = 1 + \frac{(10 + 20J) * (4*10^{-4} \angle 90)}{2}$

$= .996 \angle .115$

$B = 22.316 \angle 63.49$

$C = y = 4 \times 10^{-4} \angle 90$

$I_s = C V_r + D I_r$

$V_r = \dfrac{66 \times 10^3}{\sqrt{3}} \angle 0$

$I_r = \dfrac{P/3}{V_{r\phi} \cdot pf} \angle -\cos^{-1} pf$

$= 109.35 \angle -36.8$

$V_{s\phi} = A V_r + B I_r \rightarrow 40.151 \angle 1.67$

$I_s = C V_r + D I_r \rightarrow 100.54 \angle -29.78$

$V_{sL} = 69.54 \angle 1.67^\circ$ KV

$\eta = \dfrac{P_r}{P_{in}} \times 100 = \dfrac{10^7/3}{V_s I_s pf_s}$

$pf_s = \cos(\hat{V}_{s/\phi} - \hat{I}_s)$

$= \cos(1.67 - (-29.78)) = .85$ lag

3- A 100-Km long 3-phase, 50-Hz transmission line has the following line constants:

Resistance/Km/phase = 0.1 ohm, reactance/Km/phase = 0.5 ohm,

susceptance/Km/phase = 10×10^{-6} mho.

If the line supplies load of 20-Mw at 0.9 P.F. lagging at 66-Kv at the receiving end, calculate by nominal-π method:

(i) sending end power factor. (ii) regulation. (iii) transmission efficiency.

3) $l = 100\ Km$ $\quad 3-\phi \quad 50\ Hz$

$R/Km/\phi = 0.1\ \Omega$

$XL/Km/\phi = 0.5\ \Omega$

$y/Km/\phi = 10 * 10^{-6}\ \mho$

Load: $20\ MW$

0.9 Lag

$66\ KV$, π Connection

Req: ① Pfs ② Reg ③ η

$Z_{TL} = (.1 + J.5) * 100 = 10 + J50\ \Omega$

$y = 10 * 10^{-6} * 10^{2} = 10^{-4} * 10\ \mho$

$A = D = 1 + \frac{Zy}{2} = 0.975 \angle 0.29$

$B = Z = 50.99 \angle 78.69$ $\quad C = \left(1 + \frac{Zy}{4}\right) y = 0.988 * 10^{-3} \angle 90.15$

$V_s = 42.44 \angle 12.41$ KV

$I_s = 176.5 \angle -14.48$ A

$V_r = \frac{66K}{\sqrt{3}}$

$I_r = \frac{P/3}{V_r\, Pf} \angle -\cos^{-1} Pf$

$= 194.4 \angle -25.84$ A

$Pf = \cos(\hat{V}_s - \hat{I}_s)$

$= \cos(12.41 - (-14.48))$

$= .892$ Lag

$Reg = \frac{\left|\frac{V_s}{A}\right| - V_r}{V_r} * 100 = 14.24\%$

$\eta = \frac{P_r}{P_s} = \frac{\frac{20}{3} * 10^6}{V_s I_s Pf_s} = 99.7\%$

$42.44 * 176.5 * .892$

4- a balanced 3-phase load of 30-Mw is supplied at 132-Kv, 50-Hz and 0.85 P.F. lagging by means of a transmission line. The series impedance of a single conductor is (20 + j52) ohms and the total phase-neutral admittance is 315×10^{-6} mho. Using nominal-T method, determine:

(a) the A, B, C, and D constants of the line.

(b) sending end voltage.

(c) regulation of the line.

$X_C = \frac{1}{2\pi f C}$

حلها انت بقى رقم 4 دي شغل ايدك شوية

Sheet (5)

1. The parameters per km of three-phase 50 Hz, 280 km transmission line r=0.1 ohm/phase, x_L=0.388 ohm/phase, y=2.85*10^{-6} mho/phase.
Find the general A, B, C and D constants.

(1)

$Z = (R + jX_L) * l$

$Y = 2\pi f C * l \angle 90$

$\Rightarrow A = D = 0.9572 \angle 0.65$

$B = 110.597 \angle 75.76 \ \Omega$

$C = 7.8667 * 10^{-4} \angle 90.2 \ \mho$

2. Three-phase double-circuit 50 Hz, T.L. is 244 km long. The line parameters per phase per circuit:
r=0.0217 ohm/km, x_L=0.302 ohm/km, y=3.96*10^{-6} mho/km. The line is us supply a load of 450 MW, 500 kV at 0.85 lagging power factor. Find the g A, B, C and D constants and the sending end voltage.

$3-\phi$, douple Circuit, $f = 50\ Hz$, $l = 244\ km$

$R = 0.217\ \Omega / km / ph / circuit$

$X_L = 0.302\ \Omega / km$ ~ ~

$y = 3.96 * 10^{-6}\ \mho / km$ ~ ~

Load :- $P_r = 450\ MW$

$V_r = 500\ KV$

$Pf_r = 0.85$ Lag

Req:- A, B, C, D & V_s

Sol : For being douple Circuit ∴

$$R_T = \frac{R_{cir}}{2}$$

$$X_{LT} = \frac{X_{L cir}}{2}, \quad y_T = y_{cir} * 2$$

$$\rightarrow I_r = \frac{P_r/3}{\frac{V_r}{\sqrt{3}} * Pf_r} \angle -\cos^{-1} Pf$$

$$\rightarrow V_s = A\, \underbrace{V_r}_{\frac{500K}{\sqrt{3}}} + B\, I_r$$

$V_{s\phi} = 292.117 \angle 3.741$ KV

$V_{sL} = 505.921 \angle 3.741$ KV

(3)

3-ϕ, $F = 50$ HZ, $l = 300$ Km

$Z/Ph/Km = 0.0145 + 0.17 J$

$y/Ph/Km = 4.6 * 10^{-6}$ ℧

Load : $P_r = 150$ MW

$V_r = 220$ KV

$Pf_r = 0.9$ Lag

Req: ① A, B, C, D ② V_s, I_s, Pf_s

③ η, V_{reg} ④ V_s, I_s, Pf, Pf_s, I_{ch} → no Load

Sol:

$Z_{TL} = ((0.0145 + J0.17) * 300) = 51.185 \angle 85.125$ Ω / Ph

$y_{TL} = 4.6 * 10^{-6} * 300 \angle 90 = 13.8 * 10^{-4} \angle 90$ ℧/Ph

$\rightarrow A = D = 1 + \frac{zy}{2} = 0.965 \angle 0.18^{\circ}$ Ω

$B = Z\left(1 + \frac{zy}{6}\right) = 50.586 \angle 85.183^{\circ}$ Ω

$C = y\left(1 + \frac{zy}{6}\right) = 1.364 * 10^{-4} \angle 90.058$ ℧

$\boxed{2}$ $V_{s\phi} = A V_r + I_r B$

$V_{r\phi} = \frac{220\text{K}}{\sqrt{3}}$ V

$I_r = \frac{P_r/3}{\frac{V_r}{\sqrt{3}} * Pf_r} \angle -\cos^{-1} Pf = 437.387 \angle -25.84$ A

$V_{s\phi} = 135.254 \angle 8.255$ KV

$V_{sL} = \sqrt{3}\, V_{s\phi} = 234.267 \angle 8.255$ KV

$I_s = CV_r + DI_r = 380.397\angle -1.434^\circ$ A

$Pf_s = \cos(\hat{V}_s - \hat{I}_s) = \cos(8.255 - (-1.434)) = 0.98571$ lag

$\boxed{3}$ $\eta = \frac{P_r}{P_s} * 100 = 98.59\%$

$V_{Reg} = \frac{V_{nL} - V_{fL}}{V_{fL}} = \frac{(V_s/A) - V_{r\phi}}{V_{r\phi}} = 10.347\%$

→ note: The valid regulation is about (5%) ***

$\boxed{4}$ at no Load Condition: → $I_r = 0$

→ $V_{SL} = V_{SL,nL}$

→ I_s في الحاله دى بيكون الـ Load طبعاً مش موجود ∴ مفيش

تيار مسحوب للـ Load والتيار المسحوب كله من الـ supply هو

التيار اللى فى المكثفات.

$I_s = C * (V_s/A)$ → من المعادله = $234.267\angle 8.57$

→ $Pf_s = \cos(\hat{V}_{s,nL} - \hat{I}_{s,nL}) = 191.177\angle 98.133$

→ $P_s = 3V_{s\phi,nL} \cdot I_{s,nL} \cdot Pf_s$ = 0.00213 Lead

لأن زاويه التيار أكبر من زاويه الجهد

→ $I_{ch} = I_s = 191.177\angle 98.133$

SHEET 6

Q1: A three phase. 50 Hz overhead transmission line has A string of 3 insulators. The voltage across the insulators are E1=8 kV, E2=11kV. Find :

1. the ration between shunt capacitance and self-capacitance
2. Line to line voltage
3. String efficiency

$$3-\phi\ ;50\ Hz\ ;E1=8kV\ ;E2=11kV$$

$$\frac{C_1}{C}=k\ (required\ )$$

$$E_2=(1+k)E_1\rightarrow k=\frac{E_2-E_1}{E_!}=\frac{11-8}{8}=\frac{\mathbf{3}}{\mathbf{8}}$$

$$V_{ph}=E_1+E_2+E_3=E_1+(1+k)E_1+(1+3k+k^2)E_1=\ 37125\ V$$
$$\therefore V_L=\sqrt{3}\,V_{ph}=\ 64302.38\ V$$

$$\eta=\frac{V_{ph}}{3*(1+3k+k^2)E_1}=68.28\ \%$$

Q2: A three phase. 50 Hz overhead transmission line has a line to line voltage of 66kV The line has a string of 3 insulators, the insulator has a self-capacitance C, capacitance to ground 0.2C, capacitance between the pin and the guard ring 0.1C.

Find $\frac{E1}{VL},\frac{E2}{VL}\frac{E3}{VL}$

نفس فكره المساله الجايه باختلاف رقم بسيط والفرق انه يوضح مقارنه

Q3: redistribute the voltage in the above problem for a capacitance between the pin and the guard ring 0.3 C

Given :

$$3-\phi\quad,\qquad 50\ Hz\ \ ,C=C\ \ ,\quad C_1=0.2\ C\ ,\quad C_2=0.3\ C$$

$$\because \boldsymbol{V_2\ (C+C_2)-V_1\ (C+C_1)+V_3C_2\ =0}$$

$$V_2\ (1.3\ C)-V_1(1.2C)+V_3\ (\ 0.3\ C)=0$$

$$V_2\,(1.3) - V_1(1.2) + V_3\,(0.3) = 0 \;\rightarrow (1)$$

$$\boldsymbol{V_3(C + C_2) - V_2\,(C + C_1) - V_1 C_1 = 0}$$

$$-V_2(1.2) - V_1(0.2) + V_3\,(1.3) = 0 \rightarrow (2)$$

$$(1) \rightarrow \; 1.3\,\frac{V_2}{V_3} - 1.2\,\frac{V_1}{V_3} + 0.3 = 0$$

$$(2) \rightarrow \; -1.2\,\frac{V_2}{V_3} - 0.2\,\frac{V_1}{V_3} + 1.3 = 0$$

$$\therefore \; \frac{V_2}{V_3} = \frac{15}{17} \qquad \& \qquad \frac{V_1}{V_3} = \frac{41}{34}$$

$$\boldsymbol{V_{ph} = V_1 + V_2 + V_3}$$

$$\frac{V_{ph}}{V_3} = \frac{V_1}{V_3} + \frac{V_2}{V_3} + 1 = \frac{41}{34} + \frac{15}{17} + 1 = \frac{105}{34}$$

$$\therefore \frac{V_3}{V_{ph}} = \frac{34}{105} \quad Percentage = 32.4\,\% \quad , \qquad \frac{V_3}{V_L} = \frac{32.4\,\%}{\sqrt{3}} = 18.7\%$$

$$\frac{V_2}{V_{ph}} = \frac{15}{17} * \frac{34}{105} * 100 = 28.57\,\% \quad ; \frac{V_2}{V_L} = \frac{28.57\,\%}{\sqrt{3}} = 16.5\,\%$$

$$\frac{V_1}{V_{ph}} = \frac{41}{34} * \frac{34}{105} * 100 = 39.04\,\% \quad ; \frac{V_1}{V_L} = \frac{39.04\,\%}{\sqrt{3}} = 22.53\,\%$$

Q4: A three phase. 50 Hz overhead transmission line has a string of 4 insulators, the insulator has a self-capacitance C, capacitance to ground $\frac{C}{16}$. The insulators are designed to withstand a maximum voltage of 35kV. Find:

1.line to line voltage
2.voltage on each insulator

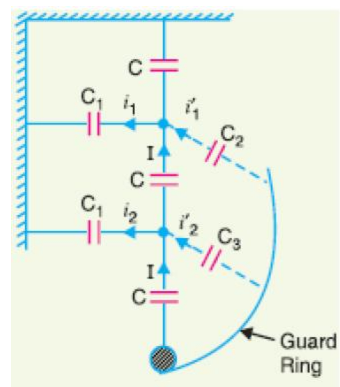
$$k = \frac{1}{16}\;; V_4 = 35kV$$

$$V_4 = (1 + 6k + 5k^2 + k^3)V_1$$

$$V_1 = \frac{V_4}{1 + 6k + 5k^2 + k^3} = 25093.6461\,V$$
$$V_2 = (1 + k)V_1 = 26661.999\,V$$
$$V_3 = (1 + 3k + k^2)V_1 = 29896.7268\,V$$

$$V_L = \sqrt{3}\,(25 + 26.6 + 29.9 + 35) = 201.78\,kV$$

Q5 : a three phase 50 Hz overhead transmission line has a string of 3 insulators , the insulator has a self capacitance C , capacitance to ground 0.2 C . Find the capacitance of guard ring that must be made to give a uniform voltage distribution across each insulator



$$C = C \quad and \quad C_1 = 0.2\,C$$
$$K = \frac{C_1}{C} = 0.2$$

To give uniform voltage distribution across each insulator

$$i_1 = i_1'$$
$$V_1\,C_1 = (V_2 + V_3)C_2$$
$$C_2 = \frac{V_1}{V_2 + V_3}\,C_1$$
$$but\ \ V_1 = V_2 = V_3$$
$$\therefore C_2 = \frac{1}{2}\,C_1 = \frac{1}{2} * 0.2 * C = \mathbf{0.1\,C}$$
$$i_2 = i_2'$$
$$(V_1 + V_2)C_1 = V_3\,C_3$$
$$C_3 = \frac{V_1 + V_2}{V_3}\,C_1 = \frac{2}{1}C_1 = 2 * 0.2\,C = \mathbf{0.4\,C}$$

SHEET 7

1. A transmission line has a span of 150-m between level supports. The cross section area of the conductor is 1.25-cm^2 and weighs 1-Kg/m. if the breaking stress is 4220-Kg/cm^2. Calculate the safety factor if the sag of the line is 3.5-m. Assume a maximum wind pressure of 50-Kg/m^2.

$$L = 150\ m \quad , A = 1.25 * 10^{-4} \ , w_c = 1\frac{kg}{m} \ , breaking\ stress = 4220\frac{kg}{cm^2}$$

$$S = 3.5\ m \quad , \quad w_e = 50\frac{kg}{m^2}$$

$$\frac{\pi}{4}D^2 = 1.25 * 10^{-4} \quad \therefore D = 0.0126\ m$$

$$\therefore w_w = 50 * (0.0126) = \ 0.63\ Kg$$

$$\therefore w_e = \sqrt{1^2 \ + 0.63^2} = 1.182\ kg$$

$$S = \frac{w_e L^2}{8T}$$

$$\therefore \ T = \left(\frac{w_e L^2}{8S}\right) = \frac{1.182 * (150)^2}{8 * 3.5} \ = \ 949.821\ kg$$

$$safety\ factor = \frac{breaking\ stress}{T} = \frac{4220 * 1.25}{949.821} = \ 5.554$$

---

2. An overhead line has a cross section area of 2.2-cm^2. Weight of conductor = 1.4-Kg/m, Ultimate strength = 8000-Kg/cm^2, wind pressure = 40-Kg/m^2 of projected area. Calculate the vertical sage of the line for a span of 300-m, assuming a factor of safety is 3.

$$A = 2.2 * 10^{-4} \quad , w_c = 1.4 \frac{kg}{m} ,$$

$$Ultimate\ Strenght = 8000 \frac{kg}{cm^2}, wind\ pressure = 40 \frac{kg}{m^2}$$

$$L = 300\ m \quad , safety\ factor = 3$$

$$safety\ factor = \frac{ultimate\ strength}{T} = \frac{8000 * 2.2}{T} = 3$$

$$\therefore\ T = 5866.667\ Kg$$

$$S_{vertical}\ (from\ conductor\ weight\ only\ ) = \frac{(1.4) * (300)^2}{8 * 5866.667} = 2.685\ m$$

---

3. An overhead line with stranded copper conductors is supported on two towers 200-m apart having a difference in level of 10-m. the conductor diameter is 2-cm and weighs 2.3-Kg/m. Calculate the sage at the lower support if wind provides a pressure of 57.5-Kg/m^2 of the projected area and a factor of safety is 4. The maximum tensile strength of copper is 4220-Kg/cm^2.

$$L = 200m , h = 10\ m \quad , \qquad D = 2 * 10^{-2} m , w_c = 2.3 \frac{kg}{m}$$

$$w_w = 57.5 \frac{kg}{m^2}, safety\ factor = 4 , breaking\ sress = 4220\ kg/cm^2$$

$$w_e = \sqrt{(2.3\ )^2 + (57.5 * 2 * 10^{-2})} = 2.538\ Kg$$

$$T = \frac{breaking\ stress}{safety\ factor} = \frac{4220 * \frac{\pi}{4} * 2^2}{4} = 3314.38\ Kg$$

$$x_1 = \frac{L}{2} - \frac{T.h}{w_e L}$$

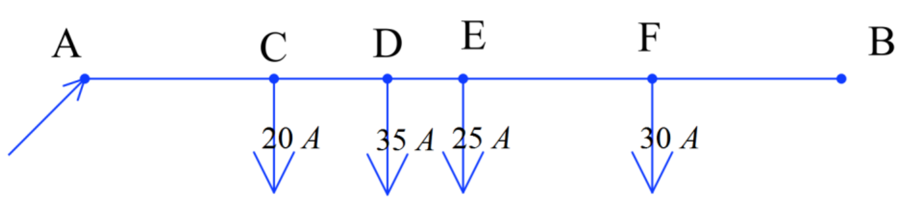
$$= 100 - \frac{3314.38 * 10}{2.538 * 200} = 34.705\ m$$

$$\therefore S_{x_1} = \frac{w_e\, x_1^2}{2T} = \frac{2.538 * (34.705)^2}{2 * 3314.38} = 0.461\ m$$

Sheet 8

1- A two-wire distributor AB is 200-m long. The resistance of each conductor is 0.4-ohm per Km. It supplies loads of 20-A, 35-A, 25-A and 30-A at points C, D, E and F situated at 50, 80, 100 and 150-m from end A. Calculate the voltage at each load point if the voltage at the feeding point A is maintained at 250-V.

$$r = \frac{0.4}{1000}\frac{\Omega}{m} \quad ; \quad L = 200\ m \ ; \ V_A = 250\ V$$



$$R_{ac} = 50 * \frac{0.4}{1000} =$$

$$R_{cd} = 30 * \frac{0.4}{1000} =$$

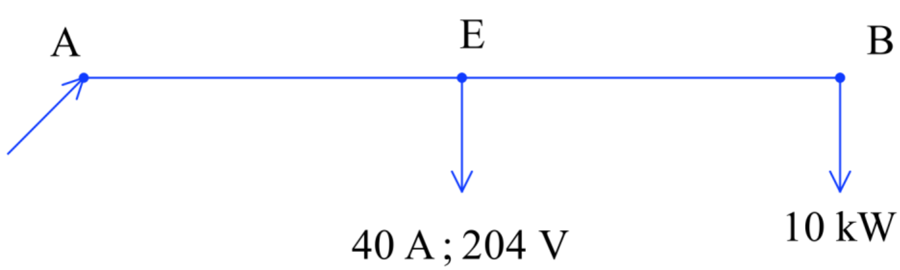
$$R_{de} = 20 * \frac{0.4}{1000} =$$

$$R_{ef} = 50 * \frac{0.4}{1000} =$$

$$V_C = 250 - 110 * R_{ac} = 250 - 110 * R_{ac}$$
$$V_D = V_C - 90 * R_{cd} =$$
$$V_E = V_D - 55 * R_{de} \ =$$
$$V_F = V_E - 30 * R_{ef} =$$

2)

2- A D.C. line has a resistance of 0.8-Ω. A load of 10-Kw is taken at far end, while at the mid point a current 40-A at 204-V is taken. Find the supply voltage.



$$R = 0.8\,\Omega$$

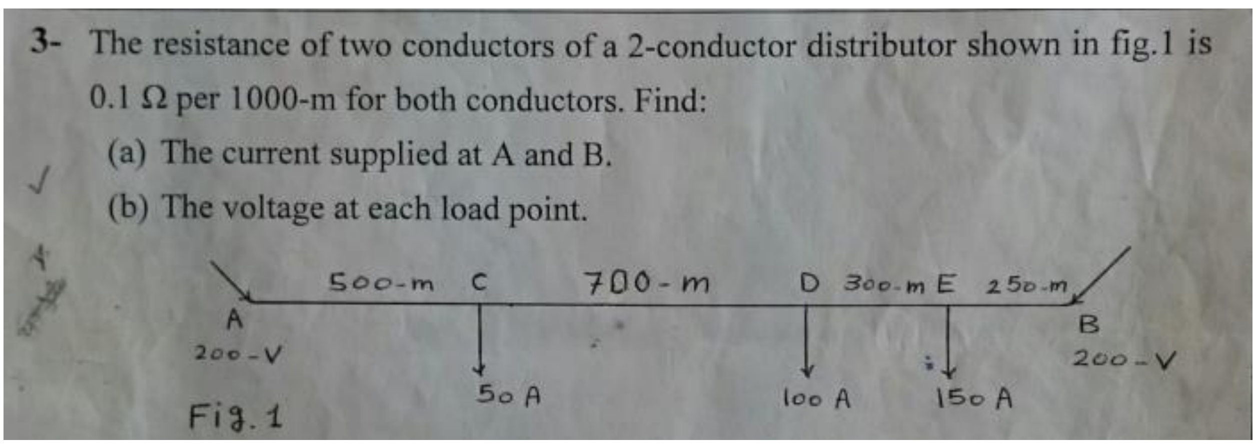
$$P_{total} = P_E \ + P_B = 204 * 40 + 10000 = \ 18160 \, watt$$

$$P_{total} = I_{total}^2 \ R_{total}$$

$$\therefore I_{total} = \sqrt{\frac{P_{total}}{R_{total}}} = \sqrt{\frac{18160}{0.8}} = 150.67 \, A$$

$$\therefore V_{supply} = \frac{P}{I} = \frac{18160}{150.67} = 120.528\ V$$

3)



3- The resistance of two conductors of a 2-conductor distributor shown in fig.1 is 0.1 Ω per 1000-m for both conductors. Find:

(a) The current supplied at A and B.

(b) The voltage at each load point.

Fig. 1

$$r = \frac{0.1}{1000}\frac{\Omega}{m} \qquad ; \qquad V_A = V_B = 200 - V$$

$$\because\ V_{AB} = 0$$

$$\therefore\ V_{AB} = I * \left(500 * \frac{0.1}{1000}\right) + (I - 50) * \left(700 * \frac{0.1}{1000}\right) + (I - 150) * \left(300 * \frac{0.1}{1000}\right) + (I - 300) * \left(250 * \frac{0.1}{1000}\right) = 0$$

$$\boldsymbol{I_A = 88.57\ A}$$

$$I_d = I_{Ad} + I_{Bd} = 38.57 + 61.43$$

$$\therefore \textit{Point of minimum voltage is } D$$

$I_c = 88.57\ A \rightarrow \quad ; \ V_c = 200 - 88.57 * 500 * \dfrac{0.1}{1000} = 195.571\ V$

$I_d = 38.57\ A \rightarrow \quad ; \ V_d = 195.571 - 38.57 * \left(700 * \dfrac{0.1}{1000}\right) = 192.871\ V$

$I_d = 61.43\ A \leftarrow \quad ; V_d = 194.714 - 61.43 * \dfrac{0.1}{1000} * 300 = 192.871\ V$

$I_e = 211.43\ A \leftarrow \quad ; \ V_e = 200 - 250 * \dfrac{0.1}{1000} * 211.43 = 194.714\ V$

$\therefore \ \boldsymbol{I_B = 211.43\ A}$

4)

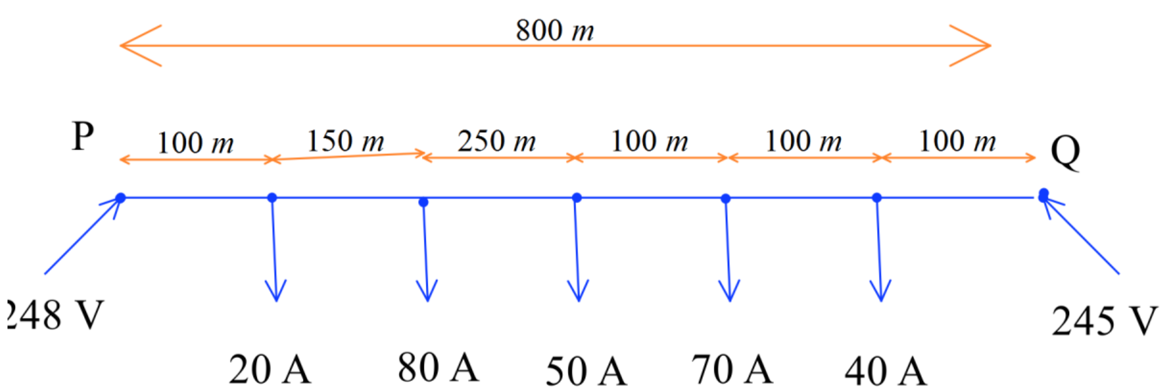
4- A 2-wire D.C. distributor PQ, 800-m long is loaded as under:

Distance from P (m)	100	250	500	600	700
Loads in amperes	20	80	50	70	40

The feeding point at P is maintained at 248-V and that at Q at 245-V. The total resistance of the distributor (go and return) is 0.1 Ω. Find:

(a) The current supplied at P and Q.

(b) The power dissipated in the distributor.



$$r = \frac{0.1}{800}\ \Omega/m$$

$$V_{PQ} = 248 - IR = 245$$

$$\therefore \ \ 3 = I * (100 * r) + (I - 20) * (150r) + (I - 100) * (250r) + (I - 150) * (100r) + (I - 220) * (100r) + (I - 260) * (100r)$$

$$\therefore I_P = \ 143.75\ A$$

$$\therefore I_Q = |143.75 - 260| = \ 116.25\ A$$

$$P = \ I^2(100r) + (I{-}20)^2(150r) + (I{-}100)^2(250r) + (I{-}150)^2(100r) + (I{-}220)^2(100r) + (I{-}260)^2(100r) = \ 847.34375\ watt$$

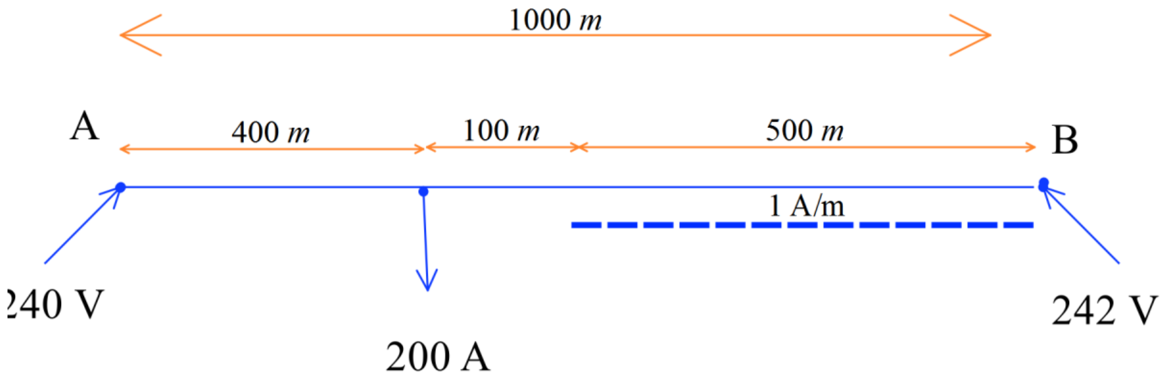
5)

5- A 2-wire D.C. distributor AB, 1000-m long is supplied from both ends, 240-V at A and 242-V at B. there is a concentrated load of 200-A at a distance of 400 metre from A and a uniformly distributed load of 1-A/m between the mid-point and end B. Determine:

(a) The current fed at A and B.

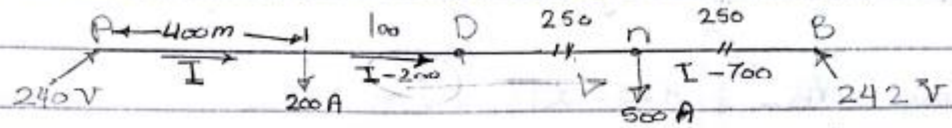
(b) The point of minimum voltage and voltage at this point.

Take cable resistance as 0.005-Ω per 100-m each core.



دي رسمتها والحل :

The approximat sol. to consider the uniformed distributed Loads as one concentrated Load.



$$V_{AB} = V_A - V_B = I R_{AC} + (I-200) R_{Cn} + (I-700) R_{nB}$$

$$240-242 = I\left(2 * \frac{.005}{100} * 400\right) + (I-200)\left(2 * \frac{.005}{100} * 350\right) + (I-700)\left(2 * \frac{.005}{100} * 250\right)$$

$$\therefore I = 225 A = I_A$$

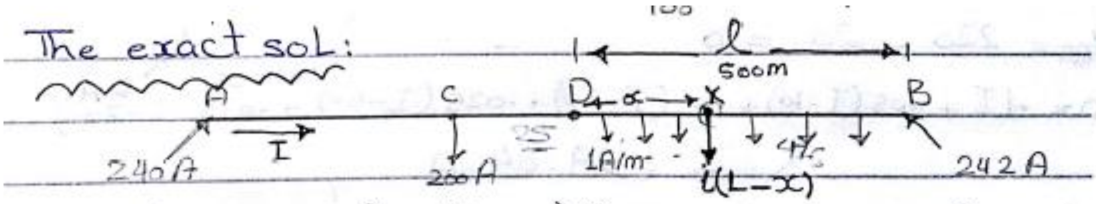
$$I_B = -(I-700) = -(225-700) = 475 A$$

point of mini. Voltage $\longrightarrow n$

$$V_n = V_B - I_B R_{nB}$$

$$= 242 - 475\left(2 * \frac{.005}{100} * 250\right) = 219.4 V$$

The exact sol:



$$V_{AB} = V_A - V_B = I R_{AC} + (I - 200) R_{CD} + V_{DB} \quad (1)$$

$$V_{DB} = \int_0^{l} \left[I - 200 - (1 * x)\right] \left(2 * \frac{.005}{100}\right) dx$$

$$= \int_0^{500} \left[I - 200 - x\right] 10^{-4}\, dx = \boxed{}$$

بالتعويض بالقيمة الناتجة من التكامل في المعادلة (1)

$$\therefore I = 225\ A = I_A$$

$$I_B = 700 - 225 = 475\ A$$

النقطة اللي بيحصل عندها تجمع للتيارات هي اللي عندها

mini Voltage

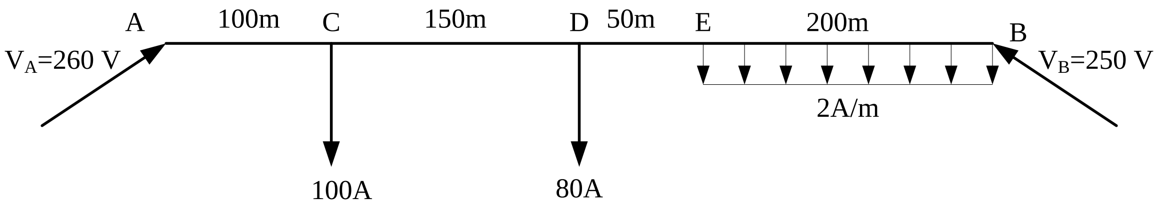
point of mini Voltage : at 475 From B

$$V_{mini} = V_B - \int_0^{475} \left[475 - x\right] \left(2 * \frac{.005}{100}\right) dx$$

$$= 242 - 10^{-4} \left[475 - \frac{x^2}{2}\right]_0^{475} = 230.72\ V$$

ناخد اختها بتاع الميدتيرم احسن وفيها رسم :

Two-wire dc distributor AB is fed from both ends as shown in the following figure. The resistance per 1000 meters is 1 Ohm. Calculate the current in various sections of the feeder, the minimum voltage and the point at which it occurs in the system. Draw the load current and voltage drop diagrams.



الحل :

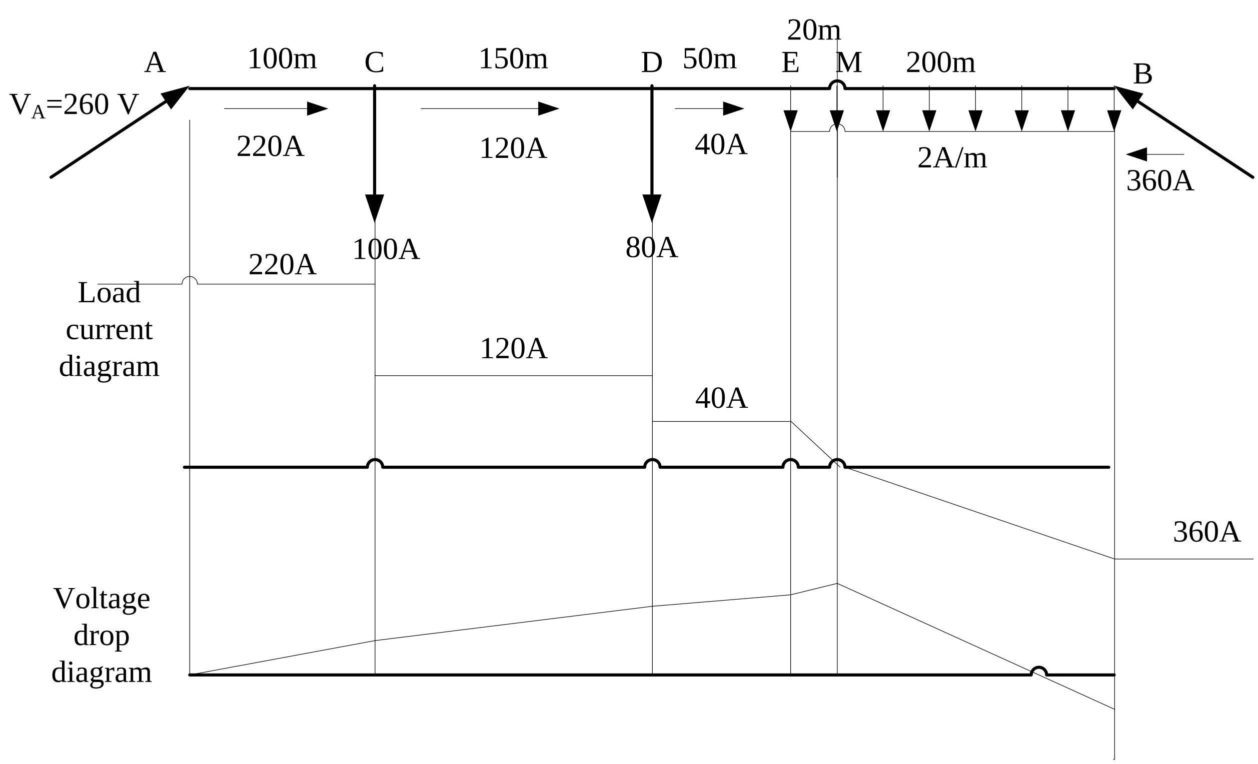
3. $R = 0.001\Omega/m, \quad \Delta V_{AB} = 0 = 0.1I_A + 0.15(I_A - 100) + 0.05(I_A - 180) + \int_0^{200} 0.001(I_A - 180 - 2x)dx$

$$\Delta V_{AB} = 10 = 0.1I_A + 0.15(I_A - 100) + 0.05(I_A - 180) + 0.001(I_A\,x - 180x - x^2)]_0^{200}$$

$0.5I_A = 110, \qquad I_A = 220A \; - - - - - - - - - - - - - - >> I_B = 360A$

$\boldsymbol{point\ of\ \min voltage\ at\ 320m\ from\ feeding\ A,} \qquad \boldsymbol{or}$
$\boldsymbol{point\ of\ \min voltage\ at\ 180m\ from\ feeding\ B}$

$$V_{Min} = V_B - \int_0^{180} 0.001(I_B - 2x)dx = 250 - 0.001(360x - x^2)]_0^{180} = 217.6V$$

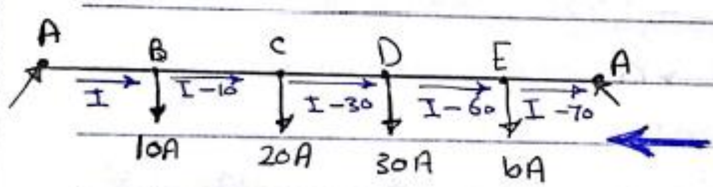


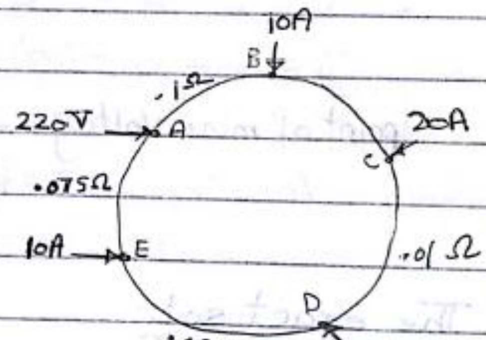
6)

6- A 2-wire D.C. distributor ABCDEA in the form of a ring main is fed at point A at 220-V and is loaded with: 10-A at B; 20-A at C; 30-A at D and 10-A at E. The resistances of various sections (go and return) are:

AB = 0.1 Ω, BC = 0.05 Ω, CD = 0.01 Ω, DE = 0.0.025 Ω and EA = 0.075 Ω.

Determine: the point of minimum voltage and Current in each section of distributor.





$V_{AA} = 220 - 220 = 0$

$0 = .1I + .05(I-10) + .01(I-30) + .025(I-60) + .075(I-70)$

$I = 29.04\ A$

$I_{AB} = 29.04$

$I_{BC} = 19.04$

Point of mini voltage → C

$I_{CD} = -.96$

$I_{DC} = -30.96$

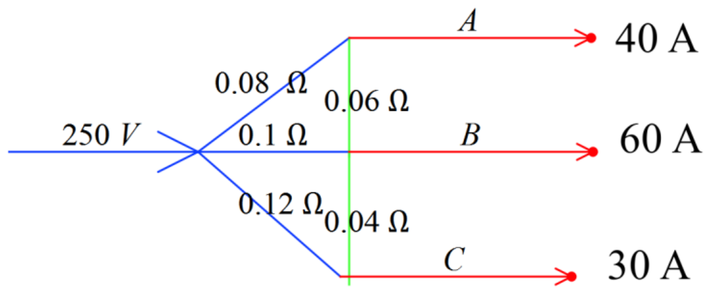
$I_{DA} = -40.96$

$V_C = V_A - I R_{AB} - R_{BC}(I-10)$

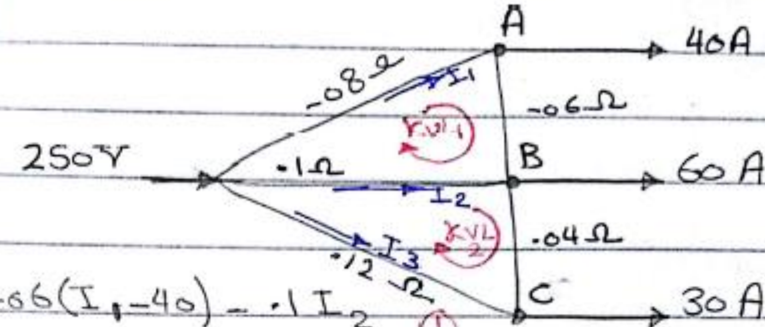
$= 216.144\ V$

7)

7- Three loads A, B, and C are connected to 250-V supply point through separate cables having resistance of 0.08, 0.1 and 0.12-Ω respectively. A is joined with B through 0.06-Ω connector and B is joined with C through 0.04-Ω connector. If the loads of 40-A, 60-A and 30-A are connected at points A, B and C respectively. Determine the voltage at these load points.



sheet8-7)



KVL 1

$0 = I_1(.08) + .06(I_1 - 40) - .1 I_2$ (1)

KVL 2

$I_2(.1) - (I_3 - 30)(.04) - I_3(.12) = 0$ (2)

KCL at B

$(I_1 - 40) + I_2 + (I_3 - 30) = 60$ (3)

solving the 3 equitions.

$I_1 = 44.3$ $I_2 = 45.05$ $I_3 = 35.56$

$V_A = 250 - I_1 * .08 = 246.056$

$V_B = 250 - I_2 * .1 = 245.5$

$V_C = 250 - I_3 * .12 = 245.7$

8- A 3-wire D.C. distributor, with the neutral of half the cross-section of either outers, 500-m long is fed at one end as shown in fig.2. The resistance of each outer conductor is 0.0005-Ω/m. Calculate the voltage at the farthest load point of 20-A.

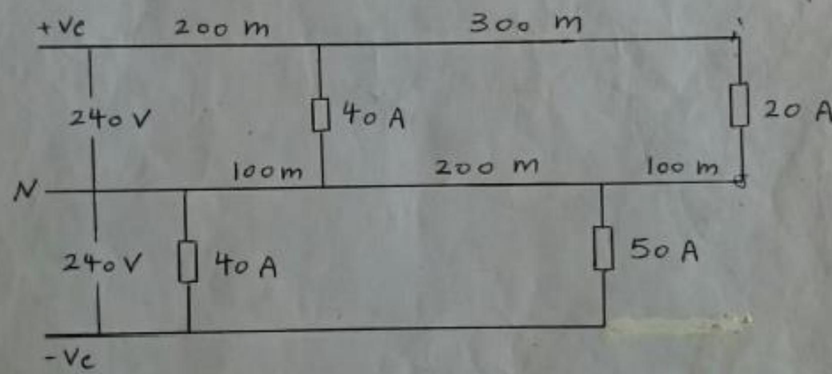


Fig. 2

$$231 - 3 = 228\ V$$

اقعد وزع مقاومات وطبق سيركتس

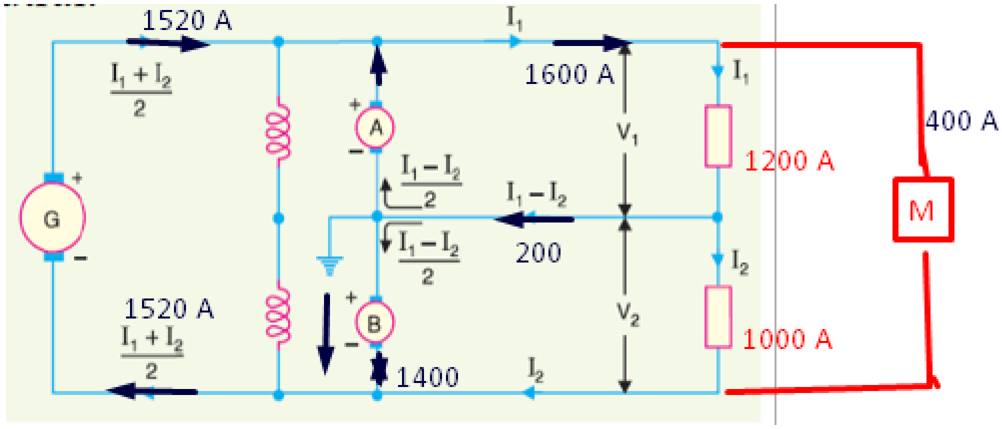
9- In a 500/250-V D.C. 3-wire, there is a current of 1200-A on the positive side and 1000-A on the negative side and a motor load of 200-Kw across the outers. The loss in each balancer machine is 5-Kw.

Calculate:

(i) current on the main generator.

(ii) Load on each balancer machine.

مهمة جداااااااااااا جاية في الإمتحان



$$\boldsymbol{total\ Power} = 1200 * 250 + 1000 * 250 + 200 * 10^3 + 2 * 5 * 10^3 = 760000\ watt$$

$$Generator\ Current = \frac{P}{V} = \frac{760000}{500} = 1520\ A$$

$$motor\ current = 200 * \frac{10^3}{500} = 400\ A$$

$$\therefore on\ A\ \ P = (1520 - 1600) * 250 = -20kW\ \ (G)$$

$$on\ B\ P = (1520 - 1400) * 250 = 30kW\ \ (M)$$

Sheet (9) AC

(1)

1- A single phase AC distributor 400-m long has a total impedance of 0.02+j0.04 ohm and is fed from one end at 250-V. It is loaded as follows:

- 40-A at unity power factor, 150-m from feeding point.
- 60-A at 0.8 lagging power factor, 250-m from feeding point.
- 50-A at 0.6 lagging power factor at the far end.

Calculate the total voltage drop and voltage at the far end.

$$Z = \frac{0.02 + j0.04}{400} = 5 * 10^{-5} + 1 * 10^{-4}\, j$$

$$I_1 = 50 \angle -cos^{-1} 0.6 = 30 - 40j$$

$$I_2 = I_1 + 60 \angle - cos^{-1} 0.8 = 78 - 76j$$

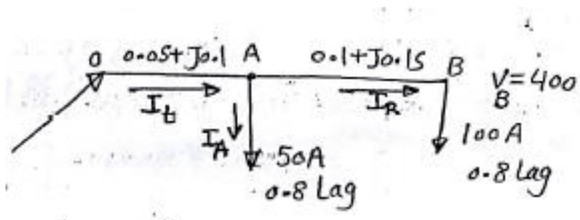
$$I_3 = I_2 + 40\angle 0 = 118 - 76\,j$$

$$\Delta V = I_3 * 150 * Z + I_2 * 100 * Z + I_1 * 100 * Z = 4 + 1.75i \;=\; 4.36\angle 23.629$$

$$V_B = V_1 - \Delta V = 250 - (\,4 + 1.75i\,) = 246 - 1.75i = 246.006\angle - 0.401$$

(2)

2- A 2-wire feeder has a load of 100-A at "B" and 50-A at "A" both at power factor 0.8 lagging. The impedance of OA is (0.05+j0.1) ohm and that of AB is
0.824 (0.1+j0.15) ohm. If the voltage at the far end "B" is maintained at 400-V, find
1.8 the voltage at "A" and at the supply end "O". Consider that the power factors are with respect to their respective voltages at the load points.



$$assume\ V_B\ refrence\ \therefore\ \ V_B = 400\,\angle 0$$

$$I_B = 100\,\angle -\cos^{-1}(0.8) + 0$$

$$I_A = 50\,\angle -\cos^{-1}(0.8) + V_A - \alpha$$

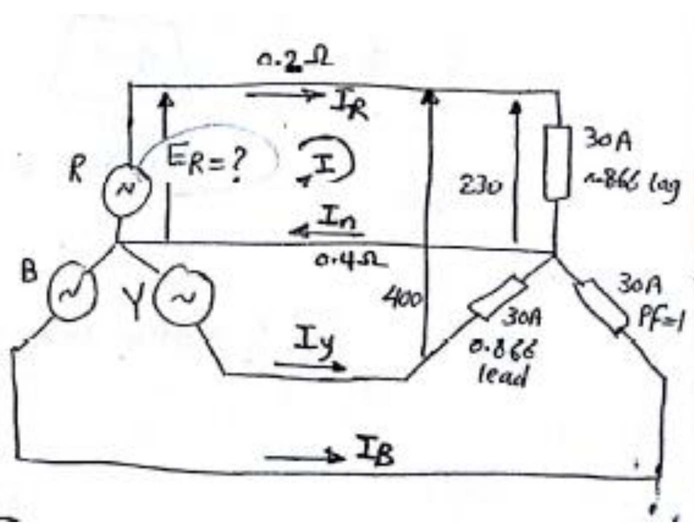
$$V_A = V_B + \ I_B * (\,0.1 + j\,0.15\,) = 417.04\angle 0.824$$

$$I_A = 50\,\angle -\cos^{-1}(0.8) + (-36.86) = 50\angle - 36.046$$

$$I_t = I_A \ + I_B =$$
$$V_O = \ \ V_A + I_t\,(\,0.05 + j\,0.1\,) = 432.17\angle 1.8\ \ volts$$

3)

3- A 3-phase, 4-wire distributor supplies a balanced voltage of 400/230-V to a load consisting of 30-A at P.F. 0.866 lagging for R phase, 30-A at P.F. 0.866 leading for Y phase and 30-A at unity P.F. for B phase. The resistance of each line conductor is 0.2 ohm. The area of cross-section of neutral is half of any line conductor. Calculate the supply end voltage for R phase. The phase sequence is RYB.



$\boxed{3}$ **Given**

3Φ, 4 wire

supply → 400/230 V

$\overset{\text{L-L}}{400}$ / $\overset{\text{L-N}}{230}$

الجهد الذى عند الحمل

load

30 A, 0.866 lag pf } → phase R

30 A, 0.866 lead } → phase Y

30 A, pf = 1 } → phase B

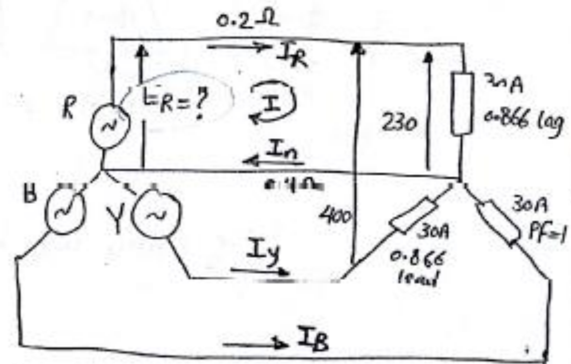
$r = 0.2\,\Omega$ for each conductor

$a_{neutral} = \frac{1}{2}\, a_{cond.}$

Sequence RYB

Require

supply voltage for phase R



Solution

$r_n = 2\, r_{cond} = 0.4\,\Omega$

load $V_R = 230\angle 0$ reference

$V_y = 230\angle -120$

$V_B = 230\angle 120$

$pf\ 0.866 \longrightarrow \phi = 30^\circ$

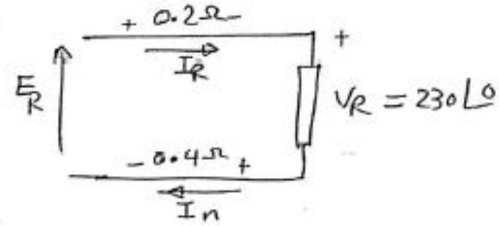
R Lag $\phi = -30$ $\qquad \hat{I} = \hat{\phi} + \hat{V} = -30 + 0 = -30$ $\qquad I_R = 30\angle -30$

Y lead $\phi = 30$ $\qquad \hat{I} = 30 - 120 = -90$ $\qquad I_y = 30\angle 90$

B $\phi = 0$ $\qquad \hat{I} = 0 + 120 = 120$ $\qquad I_B = 30\angle 120$

$I_n = I_R + I_y + I_B = 21.96\angle -60$ $\qquad$ unbalance لأن الحمل

loop①



$E_R = 0.2 I_R + 230\angle 0 + 0.4 I_n$.

$E_R = 239.8 \angle -2.53$ Volt

#

Comment

- القدرة تنتقل من الجهد الذى زاويته كبيرة الى الجهد الذى زاويته صغيرة
- فى هذه المسألة كانت زاوية الحمل (0) ، زاوية المصدر (−2.53) ← هذا يعنى أن القدرة تنتقل من الحمل للمصدر وهذا غير صحيح وذلك لأننا فى المسألة اهملنا (x) للخطوط وجعلناها مقاومة فقط لذلك حدث هذا

4- A 3-phase, 4-wire system suppiies a voltage of 400/230-V is loaded as follows:

(a) 20 HP, three-phase induction motor having an efficiency of 85% and 0.8 lagging power factor.

(b) A single phase load of 3-Kw at 0.9 lagging power factor between R and N.

(c) A single phase load of 4-Kw at unity power factor between Y and N.

(d) A single phase load of 3-Kw at 0.8 lagging power factor between B and N.

Calculate the currents in all the four wires of the system.

نشوف كل حمل بيسحب تيار كام ← من مين ثم نجمع لكل خط .

[I] Induction motor

القدرة المكتوبة عليه ← القدرة الميكانيكية التي ينتجها المحرك

وليست الكهربية التي يسحبها من المصدر

$$\eta = \frac{P_o}{P_{in}} \qquad P_{in} = \frac{P_o}{\eta} = \frac{20 * 746}{0.85} = 17.55 \text{ KW}$$

$$P_{in} = 3 \, V_{ph} \, I_{ph} \, Pf$$

$$I_{ph} = \frac{P_{in}}{3 \, V_{ph} \, Pf} = \frac{17.55 * 1000}{3 * 230 * 0.8} = 31.67 \, A$$

$Pf = 0.8$ Lag $\longrightarrow \phi = -36.87$

$$V_R = 230 \angle 0$$
$$V_y = 230 \angle -120$$
$$V_B = 230 \angle 120$$

$$I_{R1} = 31.67 \angle -36.87 \quad A$$
$$I_{y1} = 31.67 \angle -36.87 - 120 \quad A$$
$$I_{B1} = 31.67 \angle -36.87 + 120 \quad A$$

$\hat{\Phi} = \hat{\phi} + \hat{v}$

2 Second load $1-\phi$ $\quad V_R \rightarrow \theta = 0$

$$P = V_{ph}\, I_{R2}\, Pf$$

$$I_{R2} = \frac{3000}{230 * 0.9} \angle -\cos^{-1} 0.9 + 0 = 14.49 \angle -25.83$$

3 third load $1-\phi$ $\quad V_y \rightarrow \theta = -120$

$$P = V_{ph}\, I_{y2}\, Pf$$

$$I_{y2} = \frac{4000}{230 * 1} \angle 0 - 120 = 17.39 \angle -120$$

4 Forth load $1-\phi$ $\quad V_B \rightarrow \theta = 120$

$$I_{B2} = \frac{3000}{230 * 0.8} \angle -\cos^{-1} 0.8 + 120$$

$$I_R = I_{R1} + I_{R2} = 45.98 \angle -33.41 \text{ A}$$

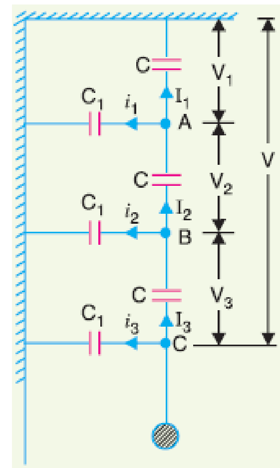
$$I_y = I_{y1} + I_{y2} = 46.76 \angle -143.98 \text{ A}$$

$$I_B = I_{B1} + I_{B2} = 42.54 \angle 83.13 \text{ A}$$

$$I_N = I_R + I_y + I_B$$

$$= 12 \angle -61.9^{\circ} \text{ A}.$$

باور سيستم

المحاضرة	الشييت	الإمتحان
 Fig. 8.11